APPENDIX B

The NRCA Roofing and Waterproofing Manual

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Note: Second printing reflects NRCA's new address, and a revision on page 81 as indicated by a vertical line in the right margin.

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ASPHALT ROOFING

I. ASPHALT ROOFING MATERIALS

A. Description

Asphalt roofing materials may be classified into two categories:

- Asphalt roll roofing materials
- Asphalt shingles

The material used to manufacture asphalt roll roofing products and asphalt shingles is called asphalt flux. It is obtained from the fractional distillation of petroleum that occurs toward the end of the distillation process. Asphalt flux is sometimes refined at the oil refinery and delivered to the asphalt roofing material manufacturer in a state that satisfies the manufacturer's specifications. Many manufacturers, however, purchase the flux themselves and do their own refining.

The more common reinforcements used in asphalt roofing materials are:

- **Organic Felts**
  Organic felts are produced from various combinations of rag, wood, and other cellulose fibers.
- **Glass Fiber Base Mats**
  Glass fiber base mats are composed of inorganic continuous or random thin glass fibers firmly bonded together with plastic binders. Generally, the glass fibers in these mats may be reinforced with additional chopped glass fiber strands or with continuous random or parallel glass fiber strands.
- **Asphalt Shingles**
  Asphalt shingles have granular surfacings and are available in a variety of styles, weights, and colors that provide a wide range of design possibilities.

Tables I and II show the dimensions and weights of typical asphalt roll roofing materials and asphalt shingles.

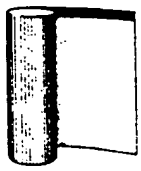
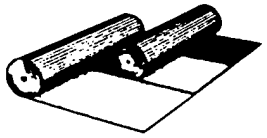
1	2		3	4		5		6	7
PRODUCT	Approximate Shipping Weight								
	Per Roll	Per Sq.	Sqs. Per Package	Length	Width	Side or End Lap	Top Lap	Exposure	Underwriters' Listing
 Mineral Surface Roll	75# to 90#	75# to 90#	One	36' 38'	36" 36"	6"	3" 4"	34" 32"	C
	Available in some areas in 4, 10 or 3, 4 square rolls								
 Mineral Surface Roll Double Coverage	55# to 70#	55# to 70#	One Half	36'	36"	6"	19"	17"	C
	*All weights and dimensions are APPROXIMATE.								

TABLE I
Typical Asphalt Roll Roofing

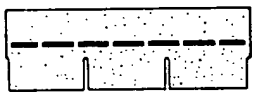
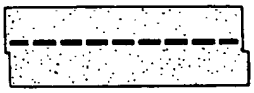
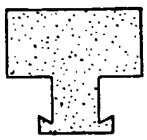
1	2	3			4		5	6
PRODUCT	Configuration	Per Square			Size		Exposure	Underwriters' Listing
		Approximate Shipping Weight	Shingles	Bundles	Width	Length		
Wood Appearance Strip Shingle More Than One Thickness Per Strip  Laminated or Job Applied	Various Edge, Surface Texture & Application Treatments	285# to 390#	67 to 90	4 or 5	11-1/2" to 15"	36" or 40"	4" to 6"	A or C - Many Wind Resistant
Wood Appearance Strip Shingle Single Thickness Per Strip 	Various Edge, Surface Texture & Application Treatments	Various 250# to 350#	78 to 90	3 or 4	12" or 12-1/4"	36" or 40"	4" to 5-1/8"	A or C - Many Wind Resistant
Self-Sealing Strip Shingle 	Conventional 3 Tab	205#-240#	78 or 80	3	12" or 12-1/4"	36"	5" or 5-1/8"	A or C - All Wind Resistant
	2 or 4 Tab	Various 215# to 325#	78 or 80	3 or 4	12" or 12-1/4"	36"	5" or 5-1/8"	
Self-Sealing Strip Shingle  No Cut Out	Various Edge and Texture Treatments	Various 215# to 290#	78 to 81	3 or 4	12" or 12-1/4"	36" or 36-1/4"	5"	A or C - All Wind Resistant
Individual Lock Down  Basic Design	Several Design Variations	180# to 250#	72 to 120	3 or 4	18" to 22-1/4"	20" to 22-1/2"	-	C - Many Wind Resistant
Other types available from some manufacturers in certain areas of the country								

TABLE II
Typical Asphalt Shingles

*All weights and dimensions are APPROXIMATE.

B. Surfacings

1. Fine Mineral Surfacings

Finely ground minerals are dusted on the surfaces of smooth asphalt roll roofing materials and on the back side of mineral-surfaced asphalt roll roofing materials to prevent the convolutions of the roll from sticking together after the material is wound into rolls. Finely ground minerals are dusted on the back side of asphalt shingles to prevent the shingles from sticking together in the package.

The materials most frequently used as mineral surfacings are talc and mica. They are not intended to be a permanent part of the finished product and will gradually depart from exposed surfaces after the roofing materials are applied.

2. Coarse Mineral Surfacings

Coarse mineral granules are used on some asphalt roll roofing products and on asphalt shingles for the following reasons:

- They protect the underlying asphalt coating from the impact of light rays; therefore, they should be opaque, dense, and properly graded for maximum coverage.
- They increase the fire resistance rating of the asphalt roofing product.
- They are available in a wide range of colors and color blends, which improves the adaptability of asphalt roofing materials to different types of buildings and provides a greater variety of design possibilities.

The materials most frequently used for coarse mineral surfacing are either natural-colored slate, natural-colored rock granules, or rock granules colored by a ceramic process.

C. Roof Deck Requirements

The following is a list of requirements for the roof deck over which asphalt roofing materials will be applied.

1. Asphalt roofing materials should be applied over solid-sheathed surfaces.
2. If plywood is used as the roof deck material, exterior plywood either $^{15}/_{32}$ inch thick for 16-inch rafter separation or $^{5}/_{8}$ inch thick for 24-inch rafter separation should be used. The plywood panels should be spaced at least $^{1}/_{16}$ inch to allow for expansion.
3. Prior to the application of asphalt roofing materials on wood-plank or plywood decks, the deck should be inspected for delamination of plywood, warped boards, and proper nailing.
4. Cementitious roof decks may provide a surface upon which asphalt roofing materials can be applied; however, manufacturers' recommendations for attachment should be reviewed and followed.

D. Roof Slope Limitations

Adequate drainage of rain water from the roof surface is essential to prevent the deterioration of asphalt roofing materials. The limitations imposed by the slope, or pitch, of the roof deck are major considerations to be made in the design of the roof.

Following are general guidelines for the application of asphalt roofing materials with respect to roof slope limitations.

1. Asphalt roll roofing material may be applied:
   - On roof decks having a slope of 4 inches per foot or more if applied parallel to the rake using the Exposed-Nail Method.
   - On roof decks having a slope of 3 inches per foot or more if applied parallel to the rake using the Concealed-Nail Method.
   - On roof decks having a slope of 2 inches per foot or more if applied parallel to the eaves using the Exposed-Nail Method.
   - On roof decks having a slope of 1 inch per foot or more if applied parallel to the eaves using the Concealed-Nail Method.
2. Nineteen-inch-selvage double-coverage roll roofing material may be applied on roof decks having a slope of 1 inch per foot or more provided the roof deck is such that rain water will drain off of the roof by gravity rather than remaining on the roof in puddles and then evaporating.
3. Asphalt self-sealing strip shingles, with tabs, may be applied:
   - On roof decks having a slope of 4 inches per foot or more if a minimum of one layer of No. 15 asphalt-saturated (non-perforated) felt is applied horizontally to serve as the underlayment.

- On roof decks having a slope of 3 inches per foot or more if a minimum of two layers of No. 15 asphalt-saturated (non-perforated) felt is applied horizontally to serve as the underlayment.

- On roof decks having a slope of 2½ inches per foot or more if a minimum of two layers of No. 15 asphalt-saturated felt are set in hot asphalt or mastic to serve as the underlayment.

4. Laminated asphalt shingles, individual lock-down shingles, and self-sealing strip shingles without tabs may be applied on roof decks having a slope of 4 inches per foot or more if a minimum one layer of No. 15 asphalt-saturated (non-perforated) felt is applied horizontally to serve as the underlayment.

E. Underlayment Requirements

1. When a single-layer underlayment is required, one layer of No. 15 asphalt-saturated (non-perforated) felt should be applied horizontally. Heavier underlayment is not usually necessary but may be required by local codes or area practice. All felt sheets should be lapped a minimum of 2 inches over the preceding felt sheet. End laps should be a minimum of 4 inches. The felts should be nailed under the lap only as necessary to hold the felts in place until the asphalt roofing material is applied. Laps may be sealed with plastic asphalt cement as required.

2. When a double-layer underlayment is required, two layers of, at a minimum, No. 15 asphalt-saturated (non-perforated) felt should be applied horizontally, as shown in Figure 1. A 19-inch-wide starter sheet should be applied to the eaves. A full-width sheet should then be applied covering the startersheet. Succeeding sheets should be lapped 19 inches (17-inch exposure) over the preceding sheets. End laps should be a minimum of 6 inches. The felts should be backnailed under the laps only as necessary to hold the felts in place until the asphalt roofing material is applied. Laps may be sealed with plastic asphalt cement as required.

3. Regardless of the type of underlayment required or of the slope of the roof, in locations where the January mean temperature is 30 F or less, two plies of No. 15 felt or one ply of No. 50 felt set in hot asphalt or mastic, or an adhered bitumen membrane should be applied as the underlayment starting from the eaves to a point 24 inches inside the inside wall line of the building to serve as an ice shield. (See Figure 1.)

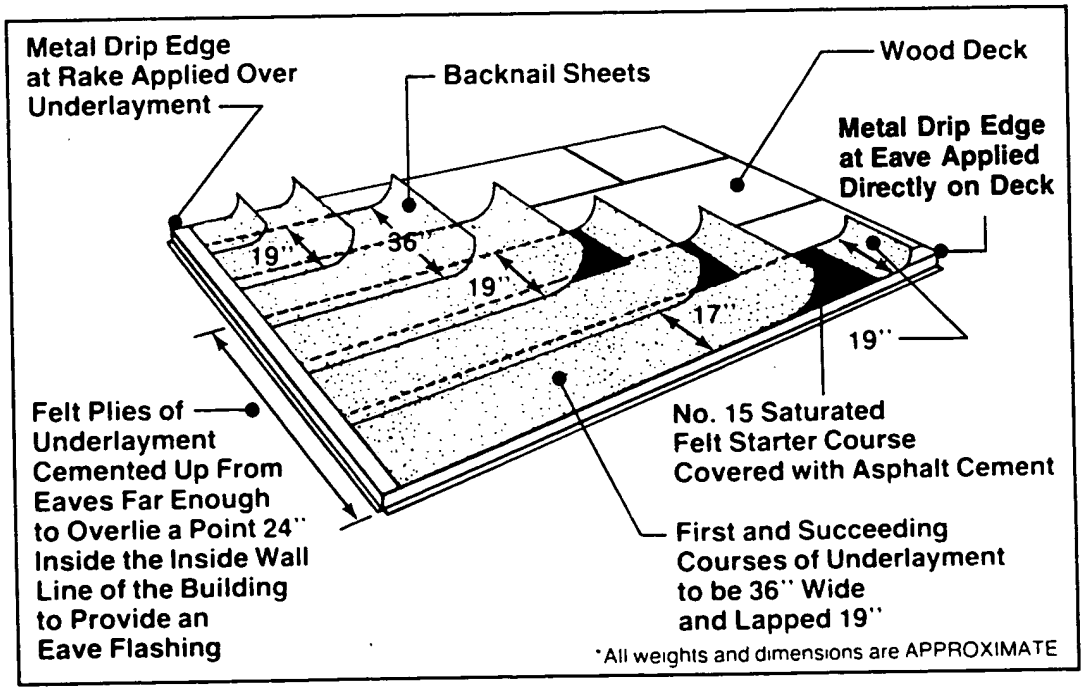


FIGURE 1
Application of Double Layer Felt Underlayment and Eave Flashing

F. Requirements for Fasteners

Following are requirements for the fasteners that are used to attach asphalt roofing materials.

10. Before personnel leave a job, all laps should be checked. Laps that have pulled away should be pressed down. Loose laps should be re-cemented to ensure tight bonding.

VI. APPLICATION OF ASPHALT SHINGLES

A. Roof Slope and Underlayment for New Construction

Following are general guidelines for the application of asphalt shingles with respect to roof slope limitations.

1. Asphalt self-sealing strip shingles, laminated asphalt shingles, and individual lock-down shingles may be applied on roof decks with slopes of 4 inches per foot or more when a minimum of one layer of No. 15 asphalt-saturated (non-perforated) felt is applied horizontally to serve as the underlayment.

2. Asphalt self-sealing strip shingles with tabs may be applied on roof decks with slopes of 3 inches per foot or more when a minimum of two layers of No. 15 asphalt-saturated (non-perforated) felt are applied horizontally to serve as the underlayment.

3. Asphalt self-sealing strip shingles with tabs may be applied on roof decks with slopes of 2½ inches per foot or more when a minimum of two layers of No. 15 asphalt-saturated felt are set in hot asphalt or mastic to serve as the underlayment.

4. On roof decks with slopes less than 4 inches per foot, and, regardless of the slope, in locations where the January mean temperature is 30 F or less, two plies of No. 15 felt or one ply of No. 50 felt, set in hot asphalt or mastic or an adhered bitumen membrane underlayment should be applied starting from the eaves to a point 24 inches inside the inside wall line to the building to serve as an ice shield. (See Figure 1.)

B. Nails

The nails used to apply all asphalt shingle materials to wood-plank or plywood roof decks should be 11- or 12-gauge hot-dipped galvanized roofing nails (or the equivalent), having large heads (at least ⅜ inch in diameter) and shanks that are ⅞ inch to 1 inch long.

Nails that are long enough to penetrate the roof sheathing or at least ¾ inch into wood-plank decks should be used over old roofing materials.

C. Drip Edge

A drip edge should be considered to allow water to drip off the roof without affecting the underlying construction. Drip edges of, at a minimum, 28-gauge galvanized metal or an equivalent non-corrosive, non-staining material should be used along eaves and rakes, applied directly to the edges of the deck. An underlayment should be provided between the metal edge and the roof deck along the rake and over the metal edge along the eave. The drip edge should extend back from the edge of the deck not more than 3 inches and should be secured with appropriate nails spaced 8 inches to 10 inches apart along its inner edge as shown in Figures 3 and 4. In high-wind areas, nails should be spaced 4 inches on center.

D. Starter Course on Shingles

The following procedures should be used to apply the starter course of asphalt shingles.

1. Before applying the first course of shingles, a row of either asphalt shingles or a 9-inch (or wider) starter strip of mineral-surfaced asphalt roll roofing material should be applied along the eaves. The lower edge or edges of the material should be even with the edge of the eaves.

2. The material should be fastened with roofing nails along a line that is parallel to and 3 or 4 inches above the eaves edge. The nails should be placed in such a way that the nail heads will not be exposed either at cutouts or at spaces between shingle tabs in the first course.

3. To apply the starter course of self-sealing shingles, the exposed (tab) portion of the shingle and 3 inches off the end of the shingle should be removed.

E. First and Succeeding Courses of Shingles

The first course of shingles should be started with full shingles while succeeding courses should be started with full or cut shingles, depending upon the style of shingles being applied and the pattern desired. Three major variations exist for the application of square-butt strip shingles.

1. Cutouts that Break Joints on Thirds

The term cutouts refers to the section cut out of an asphalt shingle to prepare it for a particular pattern of application. When it is desired that cutouts break joints on thirds:

- The SECOND course of shingles should be started with a shingle from which 4 inches have been cut.
- The THIRD course should be started with a shingle from which 8 inches have been cut.
- The FOURTH course should be started with a shingle from which the entire first tab has been cut.

This procedure will cause the cutouts to break joints on thirds with the course below. The same procedure may be repeated for courses 5, 6, and 7, or these courses may progress with shingles from which 1⅓ tabs, 1⅔ tabs and 2 tabs respectively have been cut from each first shingle before applying them to the rake. The shingles should be placed so that the lower edges of the butts are aligned with the tip of the cutouts of the underlying course. (See Figure 14.)

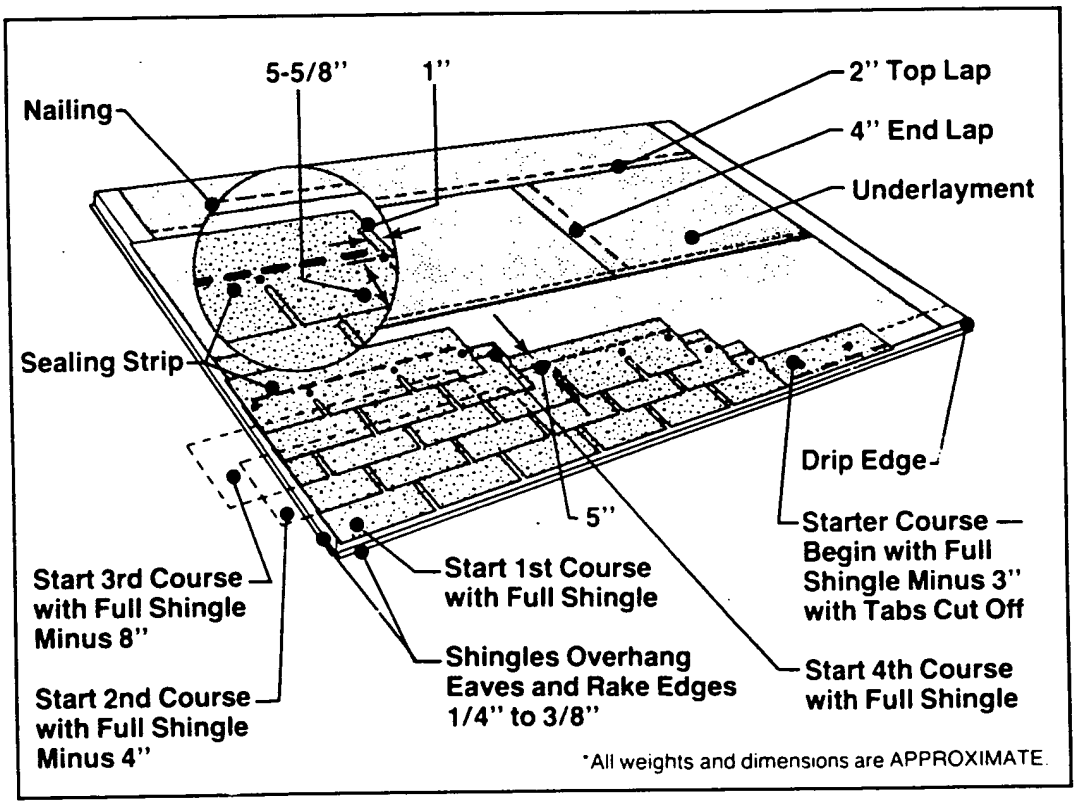


FIGURE 14
Three-Tab Square-Butt Strips—Cutouts Break Joints on Thirds

2. Cutouts that Break Joints on Halves

When it is desired that the cutouts break joints on halves:

- The SECOND course should be started with a shingle from which 6 inches have been cut.
- The THIRD course should be started with a shingle from which the entire first tab has been cut.
- The FOURTH course should be started with a one-half shingle.

This pattern allows the cutouts to be centered on the tabs of the shingles in the course following. (See Figure 15.)

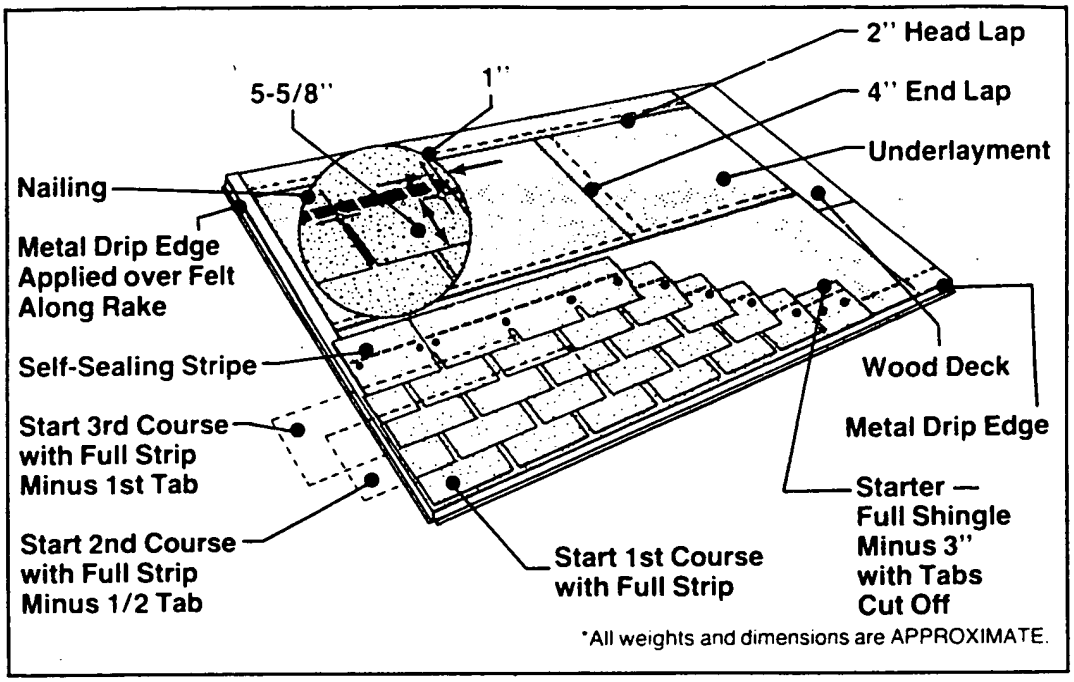


FIGURE 15
Three-Tab, Square-Butt Strips—Cutouts are Centered Over the Tabs in the Course Below

Some authorities recommend (and some applicators prefer) starting each course after the first course, up to and including the sixth course, with a shingle from which an additional half of a tab has been removed, and starting the seventh course with a full shingle. This procedure is intendedto conserve the applicator's time if much scaffolding is needed for the job.

3. Random Spacing

Random spacing can be achieved by removing different amounts of material from the rake tab of succeeding courses in accordance with the following principles:

- The width of any rake tab should be at least 3 inches.
- Cutout centerlines of any course should be located at least 3 inches laterally from the cutout centerlines in both the courses above and the courses below.
- The rake tab widths should not repeat closely enough to cause the eye to follow a cutout alignment.

Starting the first course with a full length strip will indicate the length of the starting tab for each succeeding course. This procedure is necessary to produce satisfactory random spacing.

F. Ribbon Courses

The use of a ribbon course every fifth course strengthens the horizontal roof lines and adds a distinctive, massive appearance that many home owners find desirable. (See Figure 16.)

A preferred method of ribbon course application involves a special starting procedure that is repeated every fifth course. This procedure is:

1. From the tip of a 12-inch-wide strip shingle, 4 inches should be cut away. This will provide an unbroken strip 4 inches by 36 inches in size and a strip 8 inches x 36 inches in size containing the cutouts.
2. The 4-inch by 36-inch strip should be laid along the eaves.
3. This strip should be covered with the 8-inch by 36-inch strip, with the bottom of the cutouts laid down to t' eaves.

4. This first course of full shingles (12-inch by 36-inch) should then be laid over layers B and C (see Figure 16), with the bottom of the cutouts laid down to the eaves.

IMPORTANT: Cutouts between layers A and B should be offset as explained for cutouts that break joints on third, break joints on halves or random spacing.

5. This procedure should be repeated every fifth course (or at a predetermined number of courses) by aligning the ribbon course with the tops of the cutouts of the fifth course. This method produces a triple thickness butt line at every fifth course.

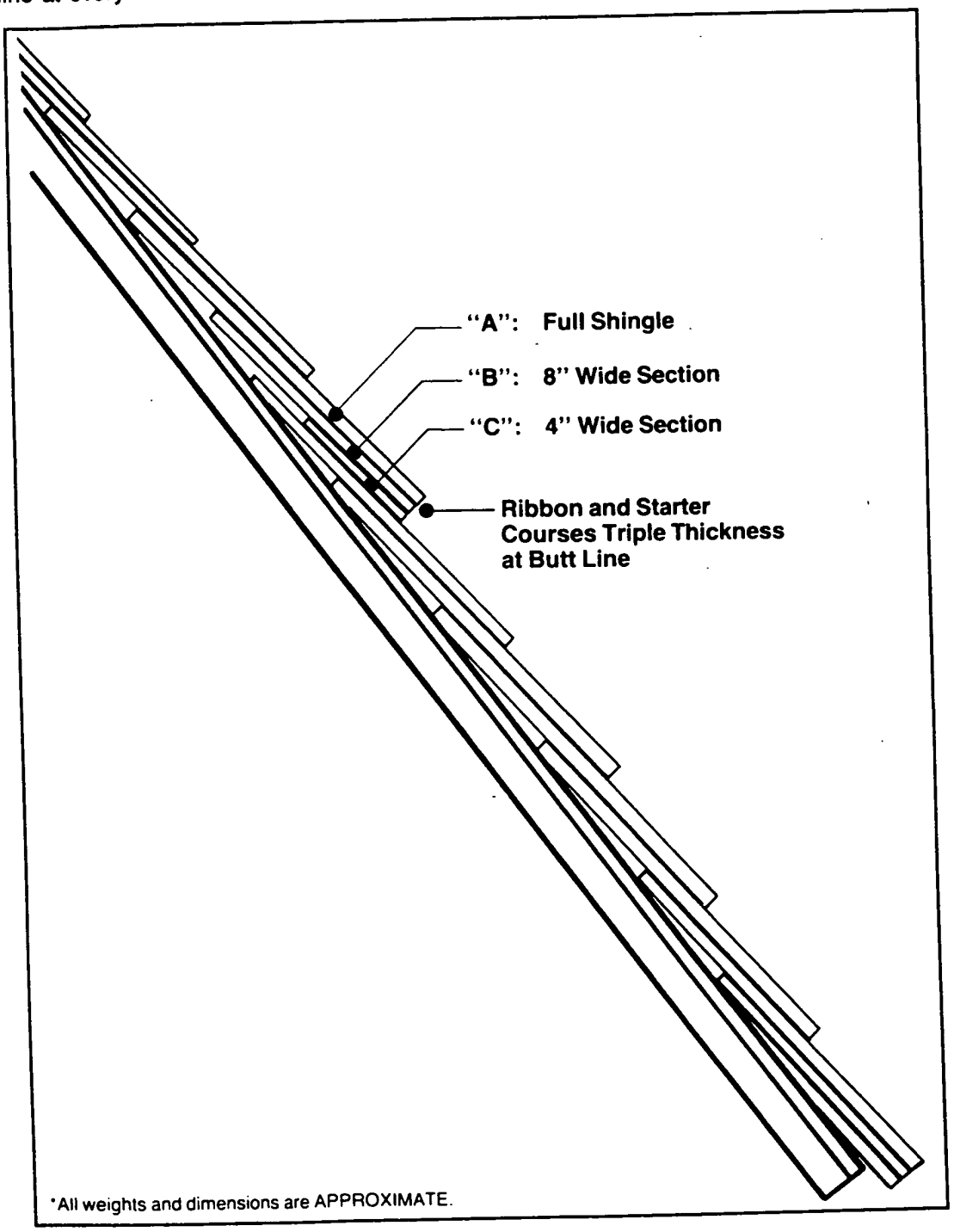


FIGURE 16
Ribbon Courses

G. Application of Shingles Over Double Underlayment

Figure 17 shows the proper application of asphalt shingles over double underlayment. Any shingle arrangement recommended for normal slope application may be used.

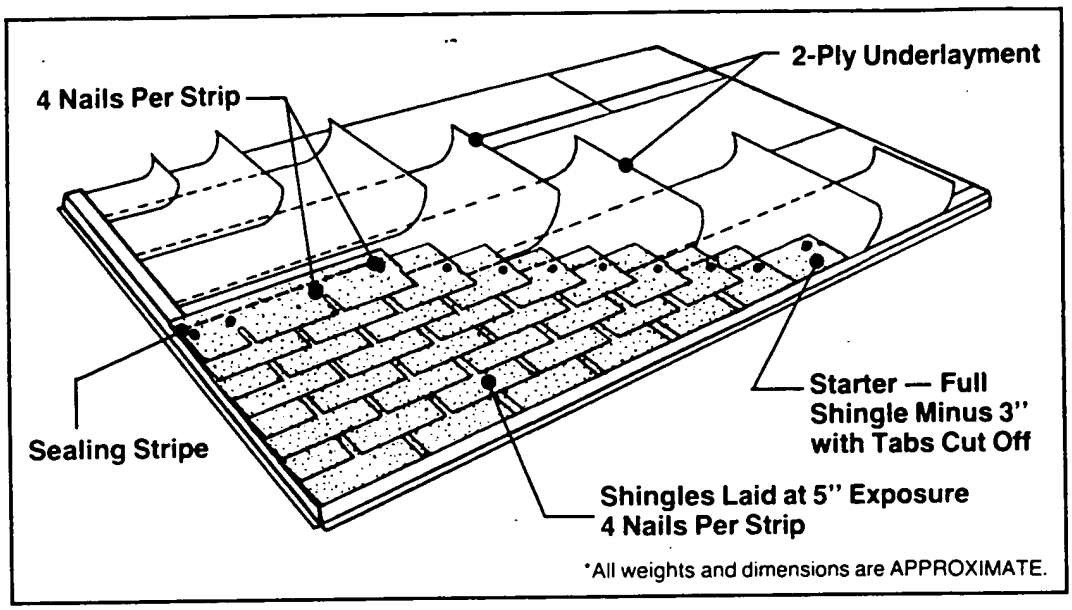


FIGURE 17
Application of Shingles Over Double Underlayment

H. Hip and Ridge Locations

The following procedures should be used to apply asphalt shingles at hip and ridge locations.

1. Asphalt shingles should be butted and nailed as they progress up either side of a hip or ridge.
2. Individual shingle tabs 12 inches by 12 inches should be cut and bent lengthwise across their centers for use as hip and ridge coverings. The unexposed portion of each tab should be cut slightly on each side so, that it is narrower than the exposed portion.
3. Application of these covers should begin at the lower end of a hip or at either end of a ridge. The covers should be applied shingle-fashion.
4. Secure each shingle with one fastener on each side 5½ inches back from the exposed end and 1 inch up from the edge.

VII. FLASHINGS

A. Description

Because residential roofs are frequently complicated by the intersection of adjoining roof sections, adjoining walls, or projections through the deck, such as chimneys and soil stacks, all of which create opportunities for leakage, special provisions for weather must be made at these locations. The devices used to control moisture entry at these locations are commonly called flashings. Careful attention to flashings is essential to good roof performance, regardless of the type of roof construction or its cost.

Asphalt shingle flashing procedures are shown in this section. Similar procedures apply to asphalt roll roofing flashings, except as noted.

For unusual flashing conditions not covered in this manual, it is suggested that the flashing material manufacturer be contacted for recommendations regarding the specific flashing procedures required.

B. Valleys

Valleys exist where two sloping roofs join at an angle. Because water runs off toward and along the valley joint and concentrates at this joint, it is especially vulnerable to leakage. A smooth, unobstructed drainage way must be provided at this location to carry water away rapidly.

The three types of valleys are:

- Open valleys
- Woven valleys
- Closed-cut valleys

Flashings for these valleys should be constructed only after the deck has been properly prepared by applying a saturated felt underlayment, as shown in Figure 18. This construction consists of a 36-inch-wide strip of No. 15 asphalt-saturated (non-perforated) felt, centered in the valley and secured with only enough nails to hold it in place until the shingles are applied. The courses of felt underlayment from the field of the roof should be cut to overlap the valley strip by not less than 6 inches. The eaves flashing strip should then be applied.

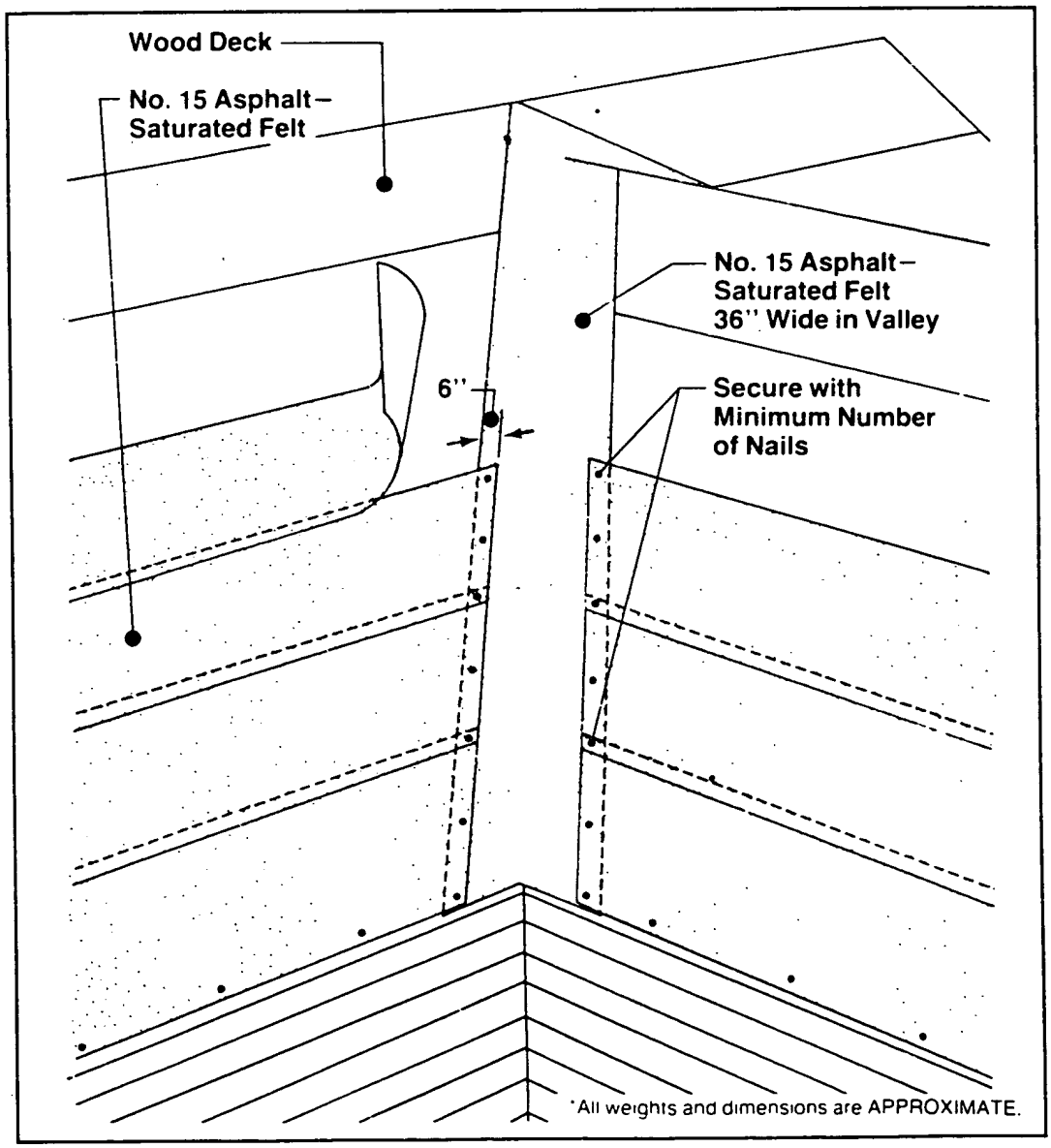


FIGURE 18
Felt Underlayment Centered in Valley